

The banks of the river Trinidad are represented by the author as being well suited for wharfs, especially in the neighbourhood of the spot he recommends as the commencement of a rail-road; but as the mouth of the Chagres is impeded by a bar, he suggests the expediency of forming a communication with the adjacent Bay of Limon, which, in its present state, affords excellent anchorage, and which, by making certain improvements in it, pointed out in the paper, might, at a small expense, be rendered one of the most commodious and safe harbours in the world.

*On the Law of the partial Polarization of Light by Reflexion.* By David Brewster, LL.D. F.R.S. L. & E. Read February, 4, 1830. [*Phil. Trans.* 1830, p. 69.]

When a beam of ordinary light is incident upon the surface of a non-metallic body, at an angle having a certain relation with its refractive density, the portion which is reflected is found to be completely polarized in the plane of reflexion; but when the angle of incidence is either greater or less than this, which is the polarizing angle, the polarization is incomplete, as is proved by transmitting the reflected beam through a doubly-refracting crystal, which decomposes it into the ordinary and extraordinary rays. What a single reflexion is unable to effect, may, however, be accomplished by a sufficient number of successive reflexions at angles different from the polarizing angle. The author had pointed out this fact in his communications to the Royal Society in the year 1815; and the further investigation of the law on which this phenomenon depends, has led him to the discovery of the real change effected in light by its reflexion, and opened new views of that condition which constitutes its polarization. The prevailing notion with regard to the condition of the light which has been imperfectly polarized by reflexion, has been, that it consisted of two portions; the one wholly polarized in the plane of reflexion, and the other not changed, but still retaining the character of natural light. This doctrine was supported by Young, Biot, Arago, and Fresnel, and more recently by Herschel. Dr. Brewster contends, in opposition to these authorities, that every portion of the reflected beam has suffered a physical change by the action of the reflecting forces, some being completely polarized, others only partially so; complete polarization consisting in the effecting of such a change in the position of the plane of polarization, as that they shall be parallel to the plane of reflexion; partial polarization, on the other hand, consisting in these planes being only brought nearer to this position of parallelism. In order to simplify the investigation, the author begins by considering the case of a beam of light composed of two polarized pencils, of which the respective planes of polarization are at right angles to each other, which two pencils may be conceived to be superposed upon each other. He then shows that the phenomena exhibited by this compound pencil are exactly the same as those exhibited by common or unpolarized light. He next proceeds

to the analysis of a pencil thus composed, after it has suffered reflexion at different angles of incidence; and for this purpose makes the plane of reflexion bisect the right angle formed by the plane of polarization of the two pencils composing the beam. As the angle of incidence diminishes from  $90^\circ$ , these latter planes are gradually turned more and more towards the plane of reflexion; so that the angles they form together become more and more acute, until the incidence becomes that of the angle of complete polarization, in the particular medium from which the reflexion takes place; in that case, the planes become parallel, and the whole of the beam is then completely polarized. As the angle of incidence still further diminishes, these planes become again inclined to one another, but in contrary directions. Thus the total polarization of the reflected pencil at the polarizing angle is effected by the turning round of the planes of polarization of one half of the light from right to left, and of the other half from left to right, each through an angle of  $45^\circ$ . But when the pencil is only partially polarized, each plane of polarization has been turned round in opposite directions, from an inclination of  $45^\circ$ , to one either less or greater than this. The light has, in this case, suffered a physical change of a remarkable kind; for it now constitutes neither natural nor polarized light, but something intermediate between both. It is not the former, because its planes of polarization are not rectangular; nor the latter, because they are not parallel. The examination of a pencil of this description by a doubly-refracting medium, which was the test employed by those who conceived the polarization to be complete in one portion while the remaining portion was wholly unpolarized, does not afford the means of deciding this question; for the results, as the author shows, would be the same in either case. By applying the law of repartition of light, when doubly refracted, between the ordinary and extraordinary rays discovered by Malus, namely, that it follows the duplicate ratio of the sine and cosine of the angle of inclination to the principal section of the crystal, we obtain the same expression for the intensities of both rays, whichever of the hypotheses we adopt. But the proof which a single reflexion is unable to afford is supplied by examining the results of a succession of reflexions. We are thus furnished with means of comparing with great precision the deductions from theory with the results of experiment, and of establishing the correctness or fallacy of both hypotheses. This investigation is pursued by the author in the body of the paper, in considerable detail. He finds the formula given by Fresnel, expressing the law of change in the plane of polarization by reflexion, to be perfectly conformable with observation, the results of which it also expresses with great accuracy when applied to rays which have undergone partial polarization. He controverts the accuracy of a proposition advanced by Arago, that equal proportions of light are polarized at equal angular distances from the angle of complete polarization. As the index of refraction differs for the different colours of the spectrum, the polarizing angle will be different in each. In bodies of high

dispersive powers, accordingly, the unpolarized light which remains in the extraordinary image must be coloured at all incidences, the colours being most distinct near the maximum polarizing angle. This necessary result of the formula, the author finds to be experimentally true in oil of cassia, and various highly dispersive bodies; hence there can be no angle of complete polarization for white light.

The same law which determines the polarization of light by reflexion is applicable also to that by refraction; in both cases, the analysing doubly-refracting crystal is insufficient to distinguish light completely polarized from light in a state of approach to polarization. The difference, however, between these two kinds of light, is marked by most distinctive characters, and shows itself in some of the most complex phenomena of interference. Hence the author is led to consider common light as composed of rays in every state of positive and negative polarization, or of particles having planes, which are acted upon by the attractive and repulsive forces residing in solid bodies; such planes having every possible variety of inclination to a plane passing through the direction of their motion. The formulæ given in the paper represent the laws according to which the repulsive and attractive forces change the position of the planes of polarization; so that the author regards all the various phenomena of the polarization of light by reflexion and refraction, as now brought under the dominion of laws as well determined as those which regulate the motions of the planets.

*A Report on the Stomach of the Zariffa. By Sir Everard Home, Bart. V.P.R.S. Read December 24, 1829. [Phil. Trans. 1830, p. 85.]*

In common with other ruminant quadrupeds, the Zariffa has a stomach consisting of four cavities. The efflorescence which lines the paunch is similar to that of the bullock, but is more prominent; the second cavity is destitute of the cellular structure met with in other ruminants, but the third and fourth cavities exhibit no peculiarities; the cud formed from the leaves and twigs of the acacia, which are the natural food of the Zariffa, is so succulent, as not to require being again moistened in passing through the second stomach, as is the case with grass; this cavity is therefore not furnished with the cells which are provided for this purpose in herbivorous quadrupeds.

Three drawings of the structure of the parts described accompany the paper.

*On the Production of regular double Refraction in the Molecules of Bodies by simple Pressure; with Observations on the Origin of the doubly refracting Structure. By David Brewster, LL.D. F.R.S. L. & E. Read February 11, 1830. [Phil. Trans. 1830, p. 87.]*

The author has already shown, in former papers which have appeared in the Philosophical Transactions, that the phenomena of